Cooperative Effort

BIOLOGICAL CONTROL OF PURPLE LOOSESTRIFE

2004 Annual Report

New Hampshire Department of Agriculture,
Markets & Food, Plant Industry Division
And
New Hampshire Department of Transportation,
Bureau of Environment

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INTRODUCTION

Purple loosestrife (*Lythrum salicaria* L.) is a member of the Lythraceae family and is a tall erect herbaceous perennial that spreads rapidly and creates monotypic stands in most wetlands it invades. It is highly adaptive to most wetland environments and tolerates a wide range of growing conditions. Economists estimate that, on average, it costs approximately $45 million annually in agricultural losses and control costs (Pimentel et al 1999). Studies also show that Purple loosestrife is spreading at a rate of 115,000 ha/yr and has resulted in the loss of native species diversity and the reduction of wildlife usage in those areas from fauna that depend on native plant diversity (Pimentel et al 1999).

HISTORICAL OVERVIEW

Purple loosestrife is a native of Eurasia where it is considered to be a non-competitive component in their wetland systems. Natural predators, primarily insects, feed on the foliage, flowers and roots of Purple loosestrife thereby reducing the plant's vigor and prevent it from taking over. However, there are no native insects that feed on Purple loosestrife here in North America. During the early 1800's cargo ships from Europe bound for North America were loaded with beach sand, which contained Purple loosestrife seeds and propagules, for ballast. Upon arrival to Long Island, New York, the sandy ballast was dumped overboard onto the adjacent shore. Historical records indicate that this is where Purple loosestrife was first introduced to North America. It is also believed that because of its medicinal qualities and its value as a garden specimen that these too were a vector for its introduction. With the optimum growing conditions and temperate climate of Long Island, it quickly spread along the shores and other inland wetland systems. Shortly after its introduction, it was able to rapidly spread inland along the shores of the Erie Canal and the St. Lawrence River. By the late 1800's and into the early 1900's its spread rapidly increased with the development of roadways and the interstate highway system. Its vivid purple magenta flowers and tall erect habit prompted horticulturists to propagate it for landscape purposes and to provide beekeepers with a new food crop. By the mid 1930's, Purple loosestrife had reached the mid-western states. Current records show that it has spread to every state in the US and has reached into parts of Canada. The heaviest populations appear to be in the Northeast Region of the US.

DESCRIPTION

Height: Purple loosestrife plants typically reaches heights of between 3 and10 ft (1-3 m) tall, however are usually 5 ft (1.5 m) in height. By the second to third growing season, each root system can produce 30 to 50 four to six sided stems that form dense canopies within a few years.

Root: The rooting structure of Purple loosestrife is highly sophisticated where it establishes numerous fibrous roots to provide support and nutrient and water uptake for the growing season and a tap root that allows it to overwinter and store carbohydrates to allow it to bolt in the early spring. The roots also have the ability to reproduce and produce offspring if they are cut or severed.

Stem: The stems develop in the early part of the growing season as soft tissue, but begin to harden and become woody in order to adequately support its large mass of vegetation. The stems are generally four to six sides and green in color. Stems developing in standing water where there is little to no oxygen adapt to this environment by generating aeranchema cells, which form along the outer surface of the stem. These cells appear whitish with a slight purple hue and are very soft and fleshy, which allows oxygen to be translocated form the upper portion of the plant to the lower stem and root structure. The stems do not overwinter. Mature plants can reach nine feet tall and form a crown that can reach five feet wide.

Leaves: The leaves are lanceolate up to 5 in (13 cm) long by 3/4 in (2 cm) wide with a cordate (blunt) leaf base. They are closely attached to the stem and are arranged in an opposite or whorled fashion in clusters of three. The upper leaf surface is smooth while the bottom surface is pubescent.

Flowers: Purple loosestrife has showy, magenta-purple flowers with 5-7 petals (occasionally appear pink or white) occurring in dense compound, terminal spikes that are typically 6-12 in (15-30 cm) high. Blooms have 8-10 stamens. The insect-pollinated flowers bloom from June to September and the flower stalks remain persistent through the winter. Each plant may bear as many as 3,000 flowers.

Reproduction: Purple loosestrife reproduces both sexually by seed and asexually by vegetative propagules. When pollination occurs a single mature and vigorous Purple loosestrife plant can produce approximately 2.5 million seeds per growing season (Welling and Becker 1990). They are relatively small, approximately 1 mm in diameter, and they have a low specific gravity allowing them to float. The seeds develop in capsules that can produce up to 120 seeds and each plant typically produces on average about 900 capsules (Shamsi and Whitehead 1974a). In late summer and throughout the winter, the capsules rupture releasing the seeds onto the ground or water below. Seeds are commonly dispersed by wind, but are also dispersed in water and mud adhering to aquatic wildlife, livestock, and people. Seed germination typically takes 8-10 weeks when soil temperatures reach 60 to 65° F (16-21° C). Seeds are long-lived and can remain viable even after 2-years being submerged in water. In addition, digging, scouring, mowing and other forms of physical damage can result in viable living root or stem propagules setting new adventitious roots or shoots, which will evolve into new plants. Furthermore, under optimum conditions, seedling densities can approach 12,000-24,000 plants/yd^2 (10,000-20,000

plants/m ^{2}) with growth rates exceeding 0.4 in/day (1 cm/day) (Rawinski 1982). Plants reproduce primarily by seeds, but also by vegetative cuttings.

Habitat: Purple loosestrife is a semi-aquatic species that becomes established in primarily freshwater wetlands including marshes, swamps, streams, rivers, ponds, lakes, bogs, wet meadows, roadside drainage ditches, and disturbed wetlands. In some instances the seeds or roots can develop under standing water conditions. They are considered to be a full-sun perennial, however, some do evolve to tolerate 50% shading.

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EARLY CONTROL EFFORTS TO MANAGE PURPLE LOOSESTRIFE

Prior to 1996, the New Hampshire Department of Transportation's (DOT) Bureau of Environment had been conducting manual eradication efforts to control Purple loosestrife in their wetland mitigation sites throughout the state. Control of Purple loosestrife was a requirement of both the State and Federal wetland permitting process. These efforts were quickly proven to be futile as it did nothing to eliminate the seed source in the soil nor was hand pulling and digging effective at total removal of all root propagules. Within one to two years, seeds germinated and the root fragments developed adventitious shoots. In 1996, the DOT prepared an Integrated Pest Management (IPM) Plan to address mechanical, cultural, chemical, and biological control aspects to manage Purple loosestrife invasions. These methods are described in detail below:

Mechanical Removal: Pulling entire plants by hand or by using a shovel is one of the best methods for removing Purple loosestrife in areas where its populations are relatively small, less than 150 plants. However, it does require that the entire plant including all of its roots be removed, bagged and disposed of in a manner that will not promote its escape, such as burying and incineration. To prevent seed dispersal, mechanical removal should be done before or during early flowering. Mowing is not recommended as it will spread vegetative propagules in a much broader area resulting in more Purple loosestrife in successive years. For several years prior to 1997, hand pulling, digging and disposal of Purple loosestrife was the only method employed by the DOT. During this period Purple loosestrife was just beginning to invade the wetland mitigation sites and so this method did prove to be somewhat effective for a short period of time. However, the Purple loosestrife did return and in much higher numbers. Due to the increased man-hours and its ineffectiveness, manual removal gave way to biological control.

Cultural Control: Cultural control involves natural succession or human intervention to manipulate the environment in which the Purple loosestrife is growing. This may include minor adjustments to soil pH, increase or decrease soil moisture, or to a greater degree the interplanting of larger shrub and tree species that will create a broader overstory canopy that will block the available sun light from reaching the Purple loosestrife. Over time, these plants will increase in size and fill the area. Since Purple loosestrife prefers full sun, a reduction in its available sunlight will impose an environmental stress that will cause the Purple loosestrife to elongate and reduce flowering and seed production in an effort to conserve its resources. For this reason, Purple loosestrife is seldom seen in wooded areas. This has proven a valuable tool in two of the DOT's wetland mitigation sites; Littleton and Nashua. In the Littleton site, several small to medium sized Speckled alder (*Alnus rugosa*) shrubs were transplanted into the areas where Purple loosestrife had invaded and within 3-4 years have created a tight canopy which is out-competing the Purple loosestrife. In the Nashua site, Speckled alders established naturally as volunteers from seed and have formed dense shrub canopies in areas suppressed by Purple loosestrife.

Chemical: Herbicide applications have been very successful in the control of Purple loosestrife throughout North America. The method of application is correlated to the population and distribution characteristics of the infestation. In areas where Purple loosestrife has created monocultures a broadcast spray application works well, but in areas where they are sporadic or where there are desirable native species, spot applications work the best. The primary disadvantage to herbicide applications is the perceived notion that the chemicals used will cause health problems. Therefore, the DOT's IPM plan identified this as being a significant issue since the majority of its wetland mitigation sites were located immediately adjacent to residentially developed areas. To date, no herbicide applications have been employed for the management of Purple loosestrife in New Hampshire.

Biological Control: The use of herbivorous insects to manage Purple loosestrife is widely recommended as a highly efficient, sustainable, cost-effective strategy. It must be noted that biological control typically do not eradicate all of its host target species, but rather significantly reduces its vigor and growth patterns so that it will remain as a component within the system, but not a dominant one. This allows the biological control insects to survive and remain at the site indefinitely so that any new Purple loosestrife plants that develop over time will be controlled. In 1992, the US Department of Agriculture (USDA) approved four insects that are native to Europe that feed solely on Purple loosestrife and which passed rigorous host specifity tests for use as biological controls here in the US. These insects include the following:

***Galerucella calmariensis* and *G. pussilla*;** The *Galerucella* beetles are host specific chrysomelids that feed on the foliage and terminal bud tissue of Purple loosestrife plants. They hail from Europe where they are natural predators of Purple loosestrife and were tested by the USDA in the early 1990's to ensure that their use as biological control agents would not impact native species when introduced to the US. There are no discernible identifying characteristics that enable easy identification of these two species, so they are generally grouped together. Both are relatively small, approximately 2-4 mm in length and are chestnut brown in color.

Galerucella calmariensis / *G. pussilla*

The adults live for up to 10 weeks and overwinter as adults in the duff or topsoil layer surrounding Purple loosestrife. Adult females can lay up to 10 eggs per day. The eggs are laid on the undersides of Purple loosestrife leaves from May to June and hatch in 2-3 weeks. The emerging larvae immediately begin to feed on the leaf where their eggs were laid. In 3 weeks the larvae drop to the soil below where they pupate for 2 weeks before emerging as adults in July and August. Upon emergence, the adults will begin feeding on the foliage, terminal buds and, stem tissue of Purple loosestrife. With the extent of defoliation caused by both larvae and adults, Purple loosestrife plants are weakened and lack the ability to fully mature, nor can they produce flower buds. The combination of the Purple loosestrife being stunted and their lack of seed production allow native species to become reestablished, therefore, restoring natural diversity and wildlife habitat.

Feeding damage from *Galerucella spp.*

Egg Mass

Larvae

Adult Feeding

***Hylobius transversovittatus*:** *Hylobius* are root-feeding weevils that are approximately 1 cm in length and are blackish grey in color. They are long lived and can overwinter in the soil for 2-3 years. The adults are nocturnal and feed on the marginal edges of Purple loosestrife leaves between June and August. Adults emerge from the soil below Purple loosestrife plants in May and within 2 weeks they oviposit 1-2 eggs either at the base of Purple loosestrife stems or they burrow in the soil and oviposit them on the taproot. Females can produce up to 200 eggs per season. When the eggs hatch, the larvae begin to tunnel their way down to the taproot where they feed on stored carbohydrates and further develop for another 2 years before emerging in July or August as adults. The extensive damage to the roots can result in total dieback of the plant.

***Nanophyes marmoratus*:** *Nanophyes marmoratus* are small Purple loosestrife feeding weevils that are native to Europe and belong to the insect family Curculionidae. The adults are host specific to Purple loosestrife and feed on their leaves, flower buds, petals, and seeds. The adults are small only about 2 to 2.5 mm in length and are blackish in appearance with lighter colored bands running perpendicular along their backs. The adults emerge in May and begin feeding on the newly formed shoots and leaves. They feed working their way up the stem and by June when flower buds form the adults bore into the buds where they will continue to feed and mate. The females will lay 60 to 100 eggs from June through September with only one egg being deposited per bud. When the eggs hatch the larvae will continue to feed on all flower parts until it has fully developed. The larvae will then pupate in the flower bud and emerge as an adult in August. In all, it's about 1 month from egg to adult. One generation of these weevils are produced per year. The feeding damage is typically so great that the Purple loosestrife cannot sexually reproduce nor set seed.

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BIOLOGICAL CONTROL PROJECT OVERVIEW

In 1997, The Department of Transportation's Bureau of Environment (DOT) and the Department of Agriculture, Markets & Food, Plant Industry, (DAMF) worked together to establish a cooperative effort for the management of Purple loosestrife populations in New Hampshire. The project was developed in accordance

with the US Department of Agriculture's Animal Plants Health Inspection Service (USDA-APHIS) Multi-State Purple Loosestrife Project. A pilot study grant in the amount of $30,000 was awarded by the DOT's State Planning and Research (SPR) program to develop the project. Sites were selected, transects were established and biological control agents were acquired. These aspects are described in more detail below:

METHODOLOGY

Site Selection: Biological release sites for the DOT wetland mitigation areas were selected based on four criteria, 1) Purple loosestrife population size; 2) Purple loosestrife density; 3) lack of standing water for the growing season, and; 4) accessibility.

Acquisition and Release of Biological Control Insects: The biological control agents being used for this project include *Galerucella calmariensis* and *G. pussilla*. The reason being is that they are readily available at a relatively limited expense, they have proven successful in other northeastern states and, they are easily established in sites of introduction. During the first few years conducting this project, these beetles were being acquired from the USDA Animal and Plant Health Inspection Service (APHIS) Plant Protection Centers in Niles, MI and Mission, TX. During the past couple of years, these facilities stopped rearing beetles and so, the beetles had to be purchased from the New Jersey Department of Agriculture's, Division of Plant Industry, Biological Pest Control Rearing Laboratory in Trenton, New Jersey. The beetles are purchased at a cost of $0.10 each, which has not changed since 1997.

Site Monitoring: The monitoring occurs during the growing season and developmental stages of the beetles. Monitoring includes a visual assessment of the of the Purple loosestrife population within the site, quantifying the percent-feeding damage, noting any predation of the leaf-feeding beetles, documenting any negative impacts the beetles may have upon native plant species and, taking panoramic photographs of the sites.

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BIOLOGICAL CONTROL RELEASE DATA

* Indicates Cooperative NH Department of Transportation & NH Department of Agriculture Efforts

** Indicates Volunteer participation for releasing beetles throughout the state

Date	Town	County	Site Location	Source	No. Beetles
6/04/97 *	Nashua	Hillsborough	TSA-1 Rte.111 Dunstable Rd.	N.J.D.A.	2,500
6/11/97 *	Nashua	Hillsborough	TSA-1 Rte.111 Dunstable Rd.	N.J.D.A.	2,500
7/01/97 *	Merrimack	Hillsborough	Camp Sargeant Rd.	Mission, TX	5,000
7/02/97 *	Littleton	Grafton	I-93 Exit 42, Sewage Treatment Plant	Mission, TX	10,000
TOTAL					**20,000**

Date	Town	County	Site Location	Source	No. Beetles
6/03/98 *	Bedford	Hillsborough	Center Road	N.J.D.A.	5,000
6/17/98 *	Nashua	Hillsborough	TSA-1 Rte.111 Dunstable Rd.	Mission, TX	1,500
6/17/98 *	Merrimack	Hillsborough	Camp Sargeant Rd.	Mission, TX	1,500
6/23/98 *	Portsmouth	Rockingham	Pease Trade Port	Mission, TX	4,500
TOTAL					**12,500**

Date	Town	County	Site Location	Source	No. Beetles
6/02/99 *	Nashua	Hillsborough	TSA-1 Rte.111 Dunstable Rd.	Niles, MI	10,000
6/02/99 *	Keene	Cheshire	Rte.9/10&12	Niles, MI	5,000
6/03/99 *	Portsmouth	Rockingham	Pease Trade Port	N.J.D.A.	5,000
6/24/99 *	New Boston	Hillsborough	Site 1	Niles, MI	10,000
6/24/99 **	New Boston	Hillsborough	Site 2	Niles, MI	10,000
6/29/99 **	Bow	Merrimack	I-89/I-93 Infield	Oregon	2,000
7/29/99 *	Manchester	Hillsborough	Candia Rd.	Oregon	1,500
7/29/99 *	Nashua	Hillsborough	Searles Rd.	Oregon	2,000
TOTAL					**45,500**

Date	Town	County	Site Location	Source	No. Beetles
6/15/00 **	Salem	Rockingham	Rockingham Blvd.	N.J.D.A.	5,000
6/16/00 **	Bow	Merrimack	I-89/I-93 Infield	Niles, MI	10,000
6/22/00 *	Hudson	Rockingham	Bensons	N.J.D.A.	5,000
6/27/00 *	Bedford	Hillsborough	Center Rd.	N.J.D.A.	5,000
7/07/00 **	Bow	Merrimack	I-89/I-93 Infield	N.J.D.A.	5,000
7/13/00 **	Bow	Merrimack	I-89/I-93 Infield	N.J.D.A.	5,000
TOTAL					**35,000**

Date	Town	County	Site Location	Source	No. Beetles
6/06/01 *	Bedford	Hillsborough	Center Rd.	N.J.D.A.	5,000
6/13/01 *	Portsmouth	Rockingham	Pease Trade Port	N.J.D.A.	500
6/13/01 *	Brentwood	Rockingham	Pine Road	N.J.D.A.	750
6/13/01 *	Manchester	Hillsborough	Candia Rd.	N.J.D.A.	1,250
6/20/01 *	Bow	Merrimack	I-89/I-93 Infield	N.J.D.A.	1,000
6/20/01 **	Rearing	N/A	N/A	N.J.D.A.	1,500
6/27/01 *	Manchester	Hillsborough	Candia Rd.	N.J.D.A.	1,400
6/27/01 **	Rearing	N/A	N/A	N.J.D.A.	1,000
7/11/01 *	Bedford	Hillsborough	Meetinghouse Rd.	N.J.D.A.	1,250
7/11/01 *	Nashua	Hillsborough	Searles Rd.	N.J.D.A.	1,250
7/11/01 *	Hudson	Hillsborough	Bensons	N.J.D.A.	1,875
7/11/01 *	Concord	Merrimack	Clinton St	N.J.D.A.	625
TOTAL					**17,400**

Date	Town	County	Site Location	Source	No. Beetles
6/04/02 *	Manchester	Hillsborough	Candia Rd.	N.J.D.A.	3,700
6/04/02 **	Rearing	N/A	N/A	N.J.D.A.	1,300
6/11/02 *	Manchester	Hillsborough	Candia Rd.	N.J.D.A.	5,000
6/18/02 *	Littleton	Grafton	Sewage Treatment	N.J.D.A.	2,500
6/18/02 **	Rearing	N/A	N/A	N.J.D.A.	2,500
6/25/02 *	Portsmouth	Rockingham	Pease Trade Port	N.J.D.A.	4,500
6/25/02 **	Rearing	N/A	N/A	N.J.D.A.	500
7/02/02 *	Brentwood	Rockingham	Pine Rd.	N.J.D.A.	5,000
7/09/02 *	Salem	Rockingham	Rockingham Blvd.	N.J.D.A.	5,000
7/16/02 *	Hudson	Hillsborough	Bensons	N.J.D.A.	2,500
7/16/02 *	Merrimack	Hillsborough	Camp Sargeant Rd.	N.J.D.A.	2,500
7/23/02 *	Tilton	Belknap	I-93 Exit 20 Infield	N.J.D.A.	2,500
7/23/02 *	Littleton	Grafton	Sewage Treatment	N.J.D.A.	2,500
TOTAL					**40,000**

Date	Town	County	Site Location	Source	No. Beetles
5/21/03 *	Portsmouth	Rockingham	Spaulding Tpk Median	APHIS	2,500
5/21/03 *	Brentwood	Rockingham	Pine Rd.	APHIS	5,000
5/21/03 *	Hudson	Hillsborough	Bensons	APHIS	2,500
6/25/03 **	Center Harbor	Belknap	Town Garage Rd.	N.J.D.A.	200
6/25/03 **	Francistown	Hillsborough	Francistown Rd.	N.J.D.A.	500
6/25/03 **	Westmoreland	Cheshire	River Rd.	N.J.D.A.	800
6/25/03 **	Plainfield	Sullivan	Silverweed Seep Preserve	N.J.D.A.	200
6/25/03 **	Walpole	Cheshire	Walpole	N.J.D.A.	200
6/25/03 **	Etna	Grafton	Hayfield rd	N.J.D.A.	600
6/25/03 **	Hanover	Grafton	Fern Ln.	N.J.D.A.	200
6/25/03 **	Littleton	Grafton	Merrimack Dr	N.J.D.A.	200
6/25/03 **	New Boston	Hillsborough	Piscataquog River	N.J.D.A.	500
6/25/03 **	Enfield	Grafton	Maple St	N.J.D.A.	200
7/02/03 *	Newington	Rockingham	Great Bay-Pease	N.J.D.A.	400
7/02/03 *	Brentwood	Rockingham	Pine Rd.	N.J.D.A.	4,600
7/16/03 *	Hopkinton	Merrimack	I-89 Median Strip	N.J.D.A.	300
7/16/03 *	Hudson	Hillsborough	Bensons	N.J.D.A.	3,000
7/31/03 *	Bedford	Hillsborough	Center Rd.	N.J.D.A.	1,000
7/31/03 *	Nashua	Hillsborough	Searles Rd.	N.J.D.A.	1,000
7/31/03 *	Salem	Rockingham	Lancelot Ct.	N.J.D.A.	1,000
TOTAL					**24,900**

Date	Town	County	Site Location	Source	No. Beetles
6/24/04 *	Hudson	Hillsborough	Bensons	APHIS	400
6/24/04 *	New castle	Rockingham	Route 1B	APHIS	250
6/24/04 *	Portsmouth	Rockingham	I-95 at Exit 3	APHIS	400
6/24/04 *	Salem	Rockingham	Pelham Rd	APHIS	250
6/24/04 *	Newington	Rockingham	Great Bay-Pease	N.J.D.A.	400
6/24/04 **	Center Harbor	Belknap	Town Garage Rd.	N.J.D.A.	200
6/24/04 **	Francistown	Hillsborough	Francistown Rd.	N.J.D.A.	500
6/24/04 **	Westmoreland	Cheshire	River Rd.	N.J.D.A.	800
6/24/04 *	Brentwood	Rockingham	Pine Rd.	N.J.D.A.	1,700
6/24/04 **	Concord	Merrimack	Franklin St	N.J.D.A.	200
6/24/04 **	New Boston	Hillsborough	Piscataquog River	N.J.D.A.	500
6/24/04 **	Portsmouth	Rockingham	Curriers Cove	N.J.D.A.	200
6/24/04 **	Bedford	Hillsborough	Greeley Hill Rd	N.J.D.A.	200
6/24/04 **	Westmoreland	Cheshire	County farm	N.J.D.A.	200
6/24/04 **	Hooksett	Merrimack	Whitehall Rd	N.J.D.A.	200
6/24/04 **	Amherst	Hillsborough	Amherst St	N.J.D.A.	200
6/24/04 **	Plainfield	Sullivan	Silverweed Seep Preserve	N.J.D.A.	200
7/09/04 *	Epping	Rockingham	Rts 125 & 101	N.J.D.A.	2,500
7/09/04 *	Brentwood	Rockingham	Pine Rd.	N.J.D.A.	900
7/09/04 *	Hampton	Rockingham	Rte 101 ROW	N.J.D.A.	1,000
7/09/04 *	Hampton	Rockingham	Rte 101 ROW	N.J.D.A.	500
8/04/04 *	Hudson	Hillsborough	Bensons	N.J.D.A.	3,000
8/04/04 *	Bedford	Hillsborough	Center Rd.	N.J.D.A.	750
8/04/04 *	Nashua	Hillsborough	Searles Rd.	N.J.D.A.	1,000
8/04/94 *	Salem	Rockingham	Lancelot Ct.	N.J.D.A.	2,000
9/01/04 *	Brentwood	Rockingham	Pine Rd.	N.J.D.A.	3,250
TOTAL					**21,700**

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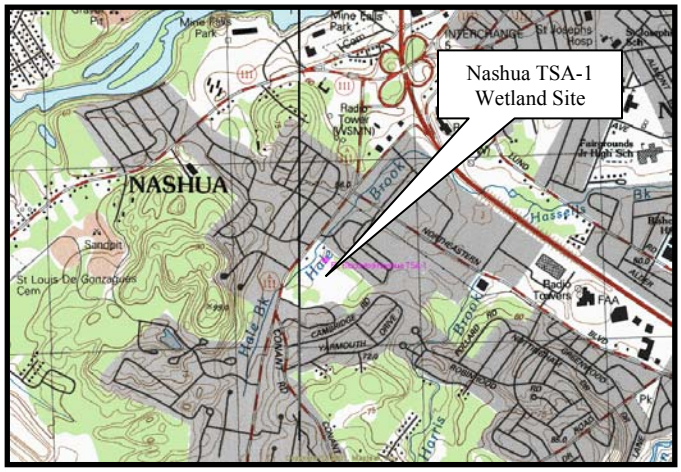
PRIMARY NHDOT & NHDAMF RELEASE SITES

Nashua - TSA-1



This site was once an old pig-farm and is located on Maine Dunstable Road/Route 111 in the City of Nashua. It was purchased by the State in 1994 to provide approximately 9 acres of emergent, scrub/shrub wetlands with a hydrologic connection to Hale Brook. The 9 acres of wetlands are divided by a raised partially wooded and open grassy knoll. The first growing season enabled the native shrubs and herbaceous seeds that were planted in these areas to become well established, however, Purple loosestrife had also come in. By 1996, Purple loosestrife had become the dominant wetland plant choking out the

native species that had been planted or came in naturally. By 1997, the Purple loosestrife had reached a maximum population density occupying approximately 90% of the wetland area with average heights of 7+ ft (2.1 m). From 1997 through 1999, approximately 16,500 beetles had been released into the site, however, there seemed to be little impact on the Purple loosestrife population, in fact, aerial photos taken each year to monitor the effects to the Purple loosestrife populations showed that the populations were actually increasing in size during this period. Then in 2000, there was almost a complete collapse of the Purple loosestrife at the site. Apparently, the *Galerucella* beetles required this amount of time to increase their populations to a level that could cause that amount of damage. Feeding damage was estimated to be 75%. Approximately 80% of the Purple loosestrife plants did not resprout and the remaining plants failed to thrive nor did any produce flower blooms. A site visit conducted in July, 2003, found evidence of an abundance of egg masses, larvae and mature adults throughout the site where Purple loosestrife still occurred. There was no evidence of beetle damage to any native plant species since the beginning of the project.

Nashua TSA-1 July 1998. Note the Purple loosestrife density.

Feeding damage from *Galerucella spp.*

Feeding damage from *Galerucella spp.*

Photo of Nashua site taken in July, 2003.

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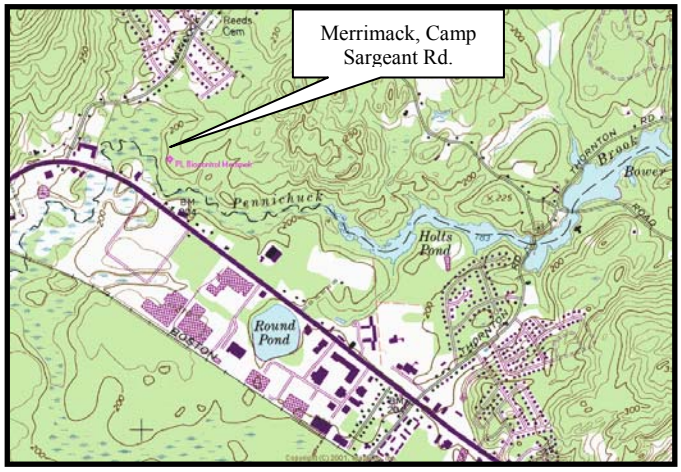
Merrimack - Camp Sargeant Road



In 1995, the DOT developed a 5 acre wetland on a site that abuts Pennichuck Brook on Camp Sargeant Road in the City of Nashua. The mitigation effort established two separate emergent wetland areas on the site; one to the north and one to the south separated by a mature stand of White pine (*Pinus strobus*). The southerly wetland has a hydrologic connection to Pennichuck Brook allowing surface water to flow in and out. However, the banks of Pennichuck Brook support a high population of Purple loosestrife, which was able to readily spread within the mitigation area. By 1996, Purple loosestrife became established in both the southerly and northerly wetlands occupying approximately 35% of the site. From 1997

through 2002, approximately 9,000 beetles had been released and by 2003, the beetle population had increased sufficiently to cause 65-70% feeding damage and cause stunting and minimize flowering.

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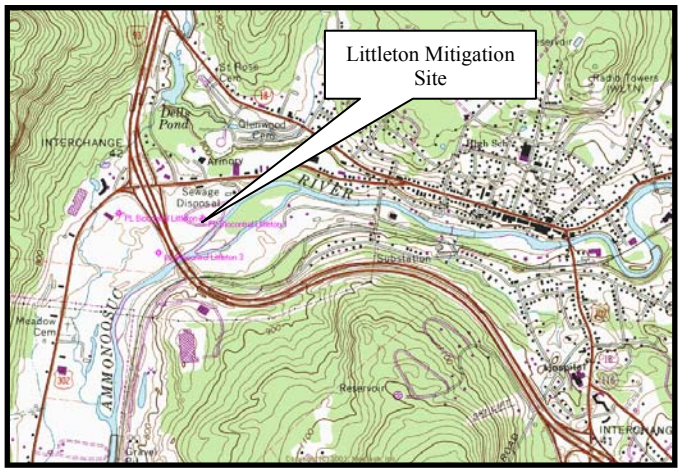
Littleton – I-93 Exit 42



Limited Purple loosestrife in 2003

This is a 4 acre wetland that was created in an old earthen fill site located on property owned by the Town of Littleton and adjacent the town's sewage treatment facility. The southerly portion of the site abuts the Ammonoosuc River. This site was constructed in 1993 and because Purple loosestrife occurred in adjacent areas it became established within the site by 1994. Hand pulling efforts failed to keep up with its spread and so additional Speckled alder (*Alnus rugosa*) were planted as a cultural control method. In 1997, 10,000 beetles were released into the site and in 2002, 2,500 were added to augment their populations. It appears that the colder climate in this region does have an effect on the beetles and their population size where only a few beetles have been found to have over wintered. In 1997, the percent Purple loosestrife coverage was estimated at 65%, but during a site visit in 2003, it had dropped to about 5%. Feeding damage was not as apparent as in previous years.

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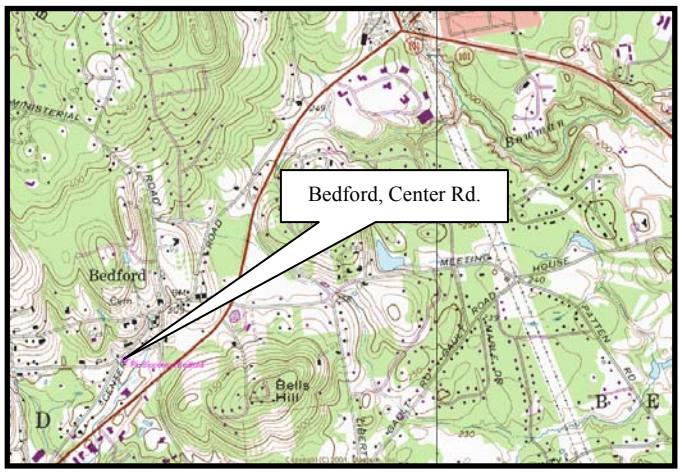
Bedford – Center Road



This is a 4 acre wetland mitigation site constructed in 1995, on a piece of property that had heavily disturbed pre-existing wetlands. The mitigation effort involved the restoration and creation of wetlands that are connected to a much larger wetland complex associated with Chandler Brook. Following construction, the site was seeded with emergent wetland species and shrubs were planted throughout the site. Unfortunately, Purple loosestrife had existed on the site before its restoration and it also occurred adjacent to the site. During the first growing season Purple loosestrife had germinated in spotty locations, but during the following year it had spread throughout the site. Hand pulling was attempted in 1996

and 1997, but failed to provide good results. From 1998 through 2003, approximately 16,000 beetles have been released into this area. The impacts to the Purple loosestrife are becoming more apparent in the last two years, but additional beetles will most likely be needed to achieve the desired results.

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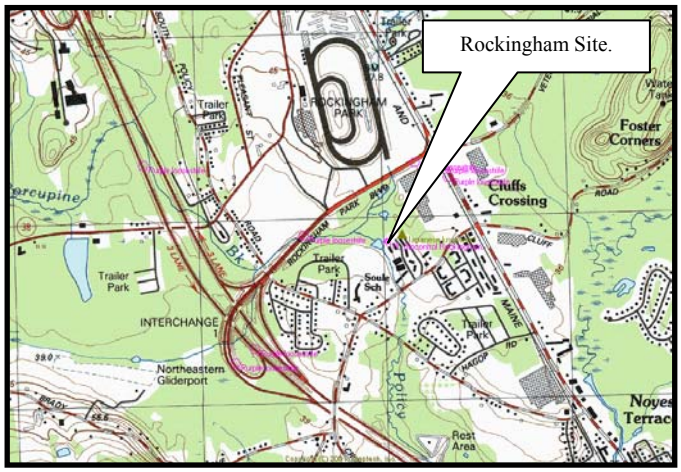
Salem –Wetland Release Site



This is a natural wetland system associated with Policy Brook located adjacent to Rockingham Boulevard in the Town of Salem. It's estimated that approximately 95% of this wetland system is a pure monoculture of Purple loosestrife leaving little space for native species. Policy Brook is a perennial tributary that flows southerly to join with the Spickett River, a tributary to the Merrimack River. Because of the interconnection of these waterways and their associated wetlands, this site was selected for biological control to help reduce the spread of the Purple loosestrife elsewhere. Between 2000 through 2003, 11,000 beetles have been released at various locations surrounding the target site. No beetle damage has been recorded at this site to date.

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Community Purple Loosestrife IPM Program

In the Spring of 1999, an Integrated Pest Management (IPM) grant was awarded to the New Hampshire Department of Agriculture, Markets and Food to develop a Community Purple Loosestrife IPM Project. The primary objective of this project is to involve the general public, conservation commissions, environmental agencies and any other interested parties in releasing Galerucella beetles into their local wetlands that are dominated by Purple loosestrife. In August of 1999, the Concord State Prison agreed to have inmates participate in the project whereby they would rear beetles for the DAMF to distribute to project participants. To date there have been 68 participants with coverage in all counties. Most of the participants are provided with approximately 200 beetles, however, organizations such as the Piscataquog Watershed Association and other environmental organizations sometimes received up to 2,000 beetles per year.

2000: The year 2000 release proved to be a very successful effort with a high degree of reproduction and resulting feeding damage.

2001: In the spring of 2001, the participants indicated that their beetles had over wintered and were doing well. In June of 2001, the participants were provided with another batch of beetles. Monitoring by the participants in the early summer found few egg masses and larvae indicating that this was not a successful year.

2002: In 2002, the State Prison no longer participated in the rearing of beetles and so adults were purchased from the New Jersey Department of Agriculture's Biological Laboratory in early June for each of the participants to rear themselves. In the spring, the DAMF held several informational seminars at various locations throughout the state to stimulate people's interest in participating in the releasing of *Galerucella* beetles in their communities. Each participant was required to dig and grow Purple loosestrife in shallow pools on their property for a few weeks prior to their receiving beetles and once they received them they had to rear them for an additional 3 -4 weeks. At the end of the rearing, the potted plants along with the beetles were taken to the wetland where they were released. The overall results for 2002, showed some evidence of egg deposition and, larvae and adult feeding damage greater than the previous year, but not to the degree anticipated.

2003: In 2003, beetles were provided to the participants in late June, which is typically later than normal, because of logistical issues. The delay in the acquisition of the beetles appears to have had a major impact upon the beetles' success this year. Soon after the participants were provided with beetles most of them noted that the beetles appeared to have disappeared into the soil in the pots and that they did not lay any eggs. There were only two participants that found eggs, but on only a few plants. It is believed that the shipment of beetles arrived after egg deposition was over for that generation.

2004: Because of the problems encountered in 2003 and the low reproductive levels found in 2002, it was decided to forego the rearing project and just have the participants do a direct release into their selected sites. Participants who monitored their sites found that they had high survival and reproductive rates than from previous years. With the improved results it was also decided to abandon the rearing program and continue forward with direct releases.

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Summary

As of 2004, this project has resulted in approximately 217,000 beetles being purchased for release into Purple loosestrife invaded wetlands throughout the State. However, the total number of beetles released is indeterminate because of the additional number of beetles that were reared during this project. With the help of the Community project and those sites managed by the DOT, all ten counties in the state are being managed with *Galerucella* beetles to some degree. The majority of the releases have occurred in towns in the central and southeastern portion of the state mainly as a result of the high density of Purple loosestrife occurring in these areas. This project will continue to provide Galerucella beetles for DOT wetland mitigation sites and other areas that become infested with Purple loosestrife as well as to those who participate in the Community Rearing Project as long as funding remains.

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